Current hospital costs and Medicare reimbursement for endovascular abdominal aortic aneurysm repair

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Objective: **The purpose of this study was to analyze the current inpatient hospital cost and Medicare reimbursement of endovascular abdominal aortic aneurysm repair (EVAR) at different hospitals.**
Methods: **The cost of EVAR from October 2000 to October 2001 with two commercially available endografts (Ancure, Guidant Endovascular Solutions, Menlo Park, Calif; and AneuRx, Medtronic AVE, Santa Rosa, Calif) was retrospectively analyzed at seven hospitals. Three university (n = 111) and four community hospitals (n = 110) from different regions of the country participated in the survey. Consecutive cases with complete financial records were included. Hospital finance departments provided their best estimates of hospital costs, including overhead for operating room, endograft, medical supply, bed, radiology, laboratory, and pharmacy services and reimbursement on the basis of hospital-specific Diagnostic Related Groups (DRG) 110 or 111. Detailed hospital charges and International Clinical Diagnosis codes also were reviewed from Universal Billing-92 forms submitted to Medicare. An additional cost analysis was performed by the authors to validate the estimates of the hospital financial departments. Outliers of more than three standard deviations from the mean were excluded.**
Results: **The mean total hospital cost was $22,999, and mean reimbursement, weighted by case mix, was $20,837, resulting in a net loss of $2162. The majority of EVAR cost was from the device (57%) and other medical supplies (16%). EVAR was reimbursed on the basis of DRG 110 in 78% of cases and of DRG 111 in 22%. Reimbursement varied widely by hospital and location (mean, $20,837; range, $14,818 to $30,343; standard deviation, $5450). With the exclusion of one hospital where reimbursement was not based on the DRG, cases reimbursed with DRG 110 resulted in an average loss of $2200, while the average loss was $9198 with DRG 111. The mean net loss for hospitals reimbursed with the DRG system was $3898.**
Conclusion: **EVAR reimbursement is presently inadequate to cover hospital expenses. Substantial financial losses occurred at four of the participating centers. University hospitals fared surprisingly better because of higher reimbursement. (J Vasc Surg 2003;37:272-9.)**

Endovascular repair is an established method for the treatment of infrarenal abdominal aortic aneurysms. Since the US Food and Drug Administration approval of two devices in September 1999, the number of endovascular abdominal aortic aneurysm repairs (EVARs) has escalated. An estimated 25,000 EVARs will be performed in the United States in 2002 according to industry market research provided by Guidant Endovascular Solution. Several other devices are in development or are in clinical trials in the United States and across the world.

Given the high expenses reported with this new technology, the cost of endovascular aneurysm repair has received considerable attention. Thus far, most studies have compared the cost of endovascular and open aneurysm repair.[1-11] The findings of these reports are conflicting. Most authors report a higher total hospital cost for EVAR in comparison[2,3,7-9,11] with open repair, although some[1,4-6] have shown equal or lower costs. These comparisons were done on endovascular repairs performed within clinical trials. The expanded indications in current practice, and the increased pricing of the commercial products, make previous analyses inapplicable in the present environment.

A complete cost analysis of new procedures such as EVAR can be quite daunting and require evaluation from many aspects. The cost of additional diagnostic studies, both before and after surgery, initial equipment purchases, and increased practice expenses, are all worthwhile issues to consider. The economic impact of a faster recovery or, in a few cases, earlier return to work are additional issues to consider. The objective of this study was limited to a survey of current hospital cost and reimbursement issues of EVAR at different medical centers across the United States. Our main aim was to determine whether the current reimbursement for EVAR is adequate to cover hospital costs. Because of the age group involved, Medicare is the dominant insurance program covering aneurysm repair, and special atten-

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tion is given to the Diagnostic Related Groups (DRG) reimbursement for these procedures.

Aside from initial outlay for equipment, specific cost and reimbursement per procedure is the most significant issue determining profitability at US hospitals from an operational standpoint. Decisions to offer EVAR or not at certain institutions have been linked to various perceptions of loss or profit with this new technology, although no studies have clearly addressed this issue after the commercialization of two endograft products.

METHODS

Participating hospitals and patient cohort. Inpatient hospital costs of EVAR were retrospectively reviewed at seven hospitals. Consecutive cases with complete financial records (n = 221) over a 12-month period from October 2000 to October 2001 were included in the study. Outliers (n = 3) of more than three standard deviations (SDs) from the mean were excluded from the primary analysis. Forty-five other cases were excluded because complete financial records were unavailable. Three university (n = 111) and four community (n = 110) hospitals from six different states provided cost data. University hospitals included Presbyterian (n = 16) and Shadyside (n = 76) Hospitals of the University of Pittsburgh Medical Center (Pittsburgh, Pa) and Dartmouth Hitchcock Medical Center (n = 19; Lebanon, NH). Community hospitals included Anne Arundel Medical Center (n = 26; Annapolis, Md), Meritcare Health System (n = 36; Fargo, ND), Martin Memorial Hospital (n = 32; Stuart, Fla), and Mercy Medical Center (n = 16; Des Moines, Iowa). The University of Pittsburgh Medical Center Institutional Review Board approved the study protocol.

Procedures were performed by vascular surgeons or interventional radiologists with commercially available devices only (Ancure, n = 191; Guidant Endovascular Solutions, Menlo Park, Calif; and AneuRx, n = 30; Medtronic AVE, Santa Rosa, Calif). Patient and endograft selection for endovascular repair was based on individual physician discretion. EVARs with nonapproved devices were excluded. Endovascular cases were captured with the International Classification of Disease-Ninth Revision-Clinical Modification (ICD-9) principle diagnosis code 441.4 (abdominal aortic aneurysm, without rupture) or procedure codes 39.71 (endovascular implantation of stent graft in abdominal aorta), 38.44 (resection of abdominal aorta with replacement), or 39.52 (other repair of aneurysm).[13,14] Cases were performed after the implementation of a specific ICD-9 procedure code for EVAR by the Center for Medicare and Medicaid Services (CMS) on October 1, 2000.

Hospitals costs. Hospital finance departments provided their "best estimates" (refer to Methods, Hospital accounting methods) of total inpatient hospital costs for each patient and a breakdown of expenses by cost center. For the purpose of this review, eight cost centers encompassing all inpatient hospital expenses were defined as follows:

1. Operating room cost center included the operating room time, anesthesia time, operating room nursing, and recovery room costs.
2. Endograft cost was considered separately.
3. Vascular implant cost center included the expense of additional endoluminal stents, stent grafts, and prosthetic grafts.
4. Medical-surgical supply cost center included equipment used for endovascular repair, such as wires, catheters, and balloons (except the vascular implants defined previously), and the remaining supplies used during admission.
5. Room expenses included regular floor, telemetry bed, and intensive care room costs.
6. Pharmacy, transfusion, and laboratory services were calculated together.
7. Radiology cost center included plain radiograph, ultrasound scan, computed tomographic scan, and other diagnostic imaging.
8. Miscellaneous cost center included same day surgery, physical and occupational therapy, and pulmonary care.

Because all hospital accounting methods were not identical, individual Universal Billing-92 (UB-92) forms and detailed billing records were reviewed when feasible and used to assign appropriate costs to the previous categories in certain cases. The UB-92 is a standard claim form used to submit hospital charges and report ICD-9 principle procedure and primary and secondary diagnosis codes. The UB-92 claim includes total inpatient charges and an itemized list of charges categorized by revenue codes. The endograft and other implantable vascular stents were identified in Supply/Implants Revenue Code 278 and 279. Itemized hospital bills for individual patients also were reviewed for selected cases from each hospital when an endograft charge was not listed on the UB-92 face sheet.

Detailed review was performed to ensure appropriate uniform billing per institution. Several cases were identified with no billing for the endograft or other gross errors, usually in the endograft and implant categories. These were corrected whenever feasible with identification of each endograft and supply item used from operative records of the individual patients and assignment of the appropriate cost according to the hospital methodology. This detailed review also allowed us to validate the finance departments cost estimates. Financial officers from the respective institutions assisted in these corrections and approved the methodology. These data are presented as the authors "best estimates" of costs.

All dollar figures presented are costs in US dollars and not charges unless specifically stated. The cost of overhead was included in all cases and for all cost centers unless specifically indicated. Professional fees and the cost of follow-up or readmission were not included in the analysis.

Hospital accounting methods. Accounting methods varied by hospital. Accounting was based on the ratio of cost to charge (RCC) method at one university and two community hospitals. The RCC accounting process has

been described elsewhere.[14] Briefly, the RCC values for the individual cost centers (ie, radiology, laboratory, pharmacy) are calculated by dividing the expenses incurred over a specific time period by the total charges for that same period. The RCC values are determined by the hospital annually and reported to CMS. Department-specific RCCs were calculated for each charged item to be representative of actual costs incurred. The cost in each cost center was determined by multiplying charges by the RCC (charge × RCC = cost). The total cost of EVAR then was calculated by adding the cost of the individual revenue cost centers.

The relative value unit (RVU) cost accounting system was used at the remaining four hospitals.[14,15] This accounting system is fully absorbable in that both direct and indirect expenses are included. In the RVU process, expenses from revenue generating centers are allocated to each of the charge items within that department. This is accomplished by separating expenses into categories such as labor, supplies, equipment depreciation, and overhead. Individual charge items then are assigned a weight or RVU. The cost per category then is spread to each charge item on the basis of its RVU. Expenses from non-revenue producing departments (overhead) are allocated to revenue-producing departments with the Medicare Cost Report Step Down Allocation. Charge item costs are reconciled to the general ledger cost for each department periodically to validate the RVU method.

Commercial software used by hospitals to track costs included products from Enterprise Performance Systems, Inc (St Louis, Mo) in one hospital and Meditech (Iatric Systems, Boxford, Mass) in another. Other institutions used proprietary accounting software to track costs.

tion.[16] DRG reimbursement can be summarized by the formula:

$$\text{DRG payment (\$)} = (\text{base payment} \times \text{relative weight}) + \text{DSH} + \text{IME} + \text{capital payment} + \text{outlier}$$

with *IME* as indirect medical education and *DSH* as disproportionate share hospital. The base payment is comprised of a standardized amount that is divided into a labor and nonlabor component on the basis of urban versus nonurban classification. The labor-related component is adjusted with a wage index that is determined on the basis of hospital geographic location defined by Metropolitan Statistical Area. The DRG relative weight accounts for differences in the mix of patients treated across hospitals. The disproportionate share hospital adjustment is made to compensate hospitals serving a relatively large volume of low-income patients. The indirect medical education adjustment is paid to approved teaching hospitals for the cost of medical education on the basis of the ratio of residents to beds. The capital payment adjustment covers capital-related expenses, such as depreciation expense. Finally, adjustments are made to compensate for outliers as the result of unusually expensive cases. Because of differences in the previous factors, payment for DRG 110 and 111 differed considerably between hospitals.

In this review, reimbursement by hospital was determined on the basis of the DRG-weighted reimbursement (DRG-WR) at each center to account for differences in the number of cases in DRG 110 and 111 at each hospital. DRG-weighted payment was calculated with the formula:

$$\text{DRG-WR (\$)} = \frac{(\text{DRG 110 payment} \times \text{DRG 110 cases}) + (\text{DRG 111 payment} \times \text{DRG 111 cases})}{\text{total number of cases}}$$

Reimbursement. Various payors were involved in reimbursement for EVAR: Medicare and other payor (73%), Medicare alone (20%), or other payor alone (7%). Because Medicare was the major payor in 93% of cases, the Medicare DRG 110 and 111 payments were used to calculate reimbursement for all cases. The DRG assigned to any procedure is based on comorbidities and complications as recorded with ICD-9 codes. EVAR reimbursement was based on DRG 110 or 111 as determined by the CMS for the year 2001. DRG 110 is assigned to major cardiovascular procedures with complicating conditions. DRG 111 is assigned to major cardiovascular procedures without complicating conditions. Some examples of complicating conditions that qualify for DRG 110 include emphysema, heart failure, urinary retention, bleeding, and many others. The base DRG payments for EVAR are higher for 110 than for 111.

DRG reimbursement is determined by several factors, including the hospital base payment, relative weight, geographic location, and teaching or nonteaching designa-

Net profit or loss was calculated with subtracting the mean DRG-WR from the mean total cost. Cases reimbursed with the DRG 110 payment were also analyzed separately from DRG 111 to compare the net profit or loss for EVAR by DRG class.

Reimbursement for EVAR at the Maryland hospital was determined differently because the state has a waiver from CMS rates.[17] Reimbursement rates are set by the Maryland Health Services Cost Review Commission (HSCRC), and all payors must pay those rates, with the exception that Medicare receives a 6% discount. Therefore, Medicare pays 94% of fee-for-service charges. However, each hospital's charges and total revenue are constrained by HSCRC DRG-set reimbursement limits. The Maryland HSCRC establishes the charge per case (CPC) rate on the basis of the DRG 110 and 111 case-mix index. If the target CPC rate is lower than the reimbursement of 94% of charges, then the hospital is required to reduce other charges to meet the target revenue for all care delivered at a particular medical center. In effect, gains realized from

Table I. Mean length of stay, total cost, DRG-weighted payment, and net profit or loss for EVAR on basis of hospitals' best estimates

Hospital	*State*	*n = 221*	*Length of stay (d)*		*Mean total cost*	*DRG weighted payment*	*Net profit or loss (–)*
			Mean	*Range*			
University affiliate	PA	76	2.0	(1-16)	$21,597	$19,669	–$1927
University	PA	16	1.9	(1-5)	$24,217	$24,915	$698
University	NH	19	1.7	(1-8)	$20,452	$22,277	$1825
Community	FL	32	4.3	(1-12)	$28,216	$16,250	–$11,966
Community	ND	36	2.2	(1-9)	$19,430	$17,590	–$1840
Community	MD	26	2.6	(1-16)	$22,087	$30,343*	$8256
Community	IA	16	2.5	(1-10)	$24,997	$14,818	–$10,179
Mean			2.4		$22,999	$20,837	–$2162

*Reimbursement at non-Medicare rate of 94% of charges.

Table II. Mean total cost, DRG-weighted payment, and net profit or loss for EVAR on basis of authors' best estimates

Hospital	*State*	*n = 221*	*Total cost*	*DRG-weighted payment*	*Net profit or loss (–)*
University affiliate	PA	76	$21,475	$19,669	–$1806
University	PA	16	$24,385	$24,915	$530
University	NH	19	$20,452	$22,277	$1825
Community	FL	32	$28,216	$16,250	–$11,966
Community	ND	36	$19,682	$17,590	–$2092
Community	MD	26	$22,087	$18,989*	–$3098
Community	IA	16	$24,977	$14,818	–$10,179
Mean			$23,042	$19,215	–$3827

*Reimbursement based on Maryland HSCRC CPC rate.

EVAR result in reduced revenue from other hospital services. Because the CPC rate is the effective hospital reimbursement, this was used as the authors' best estimate.

Net profit or loss. Mean hospital costs and mean DRG-WR were analyzed to determine net profit or loss. Length of stay also was recorded. A separate analysis of cost was done that included outliers.

RESULTS

Hospital costs and reimbursement. Mean length of stay, total costs, DRG-WR, and net profit or loss per hospital on the basis of the hospital's best estimates are shown in Table I. The mean length of stay was 2.4 days for all patients in the study, with a range of 1.7 to 4.3 days. The mean total cost for EVAR for all hospitals was $22,999 (range, $19,430 to $28,216; SD, $3020). Mean total costs varied widely between hospitals. The highest average cost of $28,216 reported by a community hospital was only partly because of a longer length of stay. With a mean DRG-WR of $20,837 (range, $14,818 to $34,343; SD, $5450), the hospitals incurred a net loss of $2162 per case. Of note, the large profit reported by one community hospital is because of a specific reimbursement scheme unique to the state of Maryland.

The authors' best estimates of costs and reimbursement after corrections are shown in Table II. The mean total hospital cost for EVAR for all hospitals was $23,042. This figure was nearly identical to the hospital's estimate, differing by only $43. Mean total hospital costs differed slightly at three hospitals, mainly because of errors or omissions in charging for the endograft. The main correction introduced by the authors involves the effective reimbursement in the Maryland hospital. The figure in Table II is the CPC value established by the Maryland HSCRC as described in the Methods section. The mean total charge for the admission was $32,280. Because payment is set at 94% of charges, the mean reimbursement for EVAR was $30,343, reported in Table I. Because hospital inpatient revenue is regulated, the CPC target rate of $18,989 is the effective hospital reimbursement in Maryland. Factoring in of the CPC resulted in a real net loss of $3098 per case, instead of an $8256 profit.

Substantial differences existed in DRG-WR, with a range of $14,818 to $24,915. The lowest DRG-WR of $14,818 was the result of a higher percentage of cases covered with DRG 111 (6/16; 37.5%) and the lower base DRG payments at the community hospital involved. As expected, DRG-WR was higher at the three university hospitals compared with the community hospitals. According to the authors' best estimates, the net loss across all hospitals was higher than the hospital's estimate at $3827. Two university hospitals paid with the DRG system realized a net gain for EVAR because of higher DRG payments. Overall, EVAR resulted in a net loss according to both the hospitals' and the authors' cost analyses.

Table III. Detailed mean costs of EVAR by cost center including overhead (see text for description of individual cost centers)

Hospital	*Total cost*	*Endograft**	*Vascular implant†*	*Medical surgical supply*	*Operating room service*	*Room*	*Pharmacy + laboratory + blood*	*Radiology*	*Other*
University affiliate	$21,475	$13,038	$1914	$2035	$1550	$1226	$929	$308	$476
University	$24,385	$12,935	$752	$1830	$5348	$664	$2413	$400	$42
University	$20,452	$15,536	$1099	$1666	$1304	$1047	$542	$150	$207
Community	$28,216	$15,546	$1283	$3615	$3075	$1950	$1316	$791	$640
Community	$19,682	$9,361	N/A	$2894	$1249	$955	$1241	$3807	$175
Community	$22,087	$9,963	$2937	$2868	$3542	$1639	$719	$264	$154
Community	$24,997	$15,960	$107	$2576	$2486	$1834	$696	$884	$455
Mean	$23,042	$13,191	$1116	$2498	$2651	$1331	$1122	$943	$307

*Hospitals assigned varying overhead costs to endograft.
†Vascular implants are stents, stent grafts, and prosthetics other than endograft.
N/A, Not applicable.

Cost centers. A further breakdown of hospital expenses by cost center revealed how costs were distributed across service departments. The detailed breakdown of hospital costs with overhead according to cost center is shown in Table III. Most of the EVAR cost was from the endograft, medical-surgical supplies, and operating room services. The endovascular graft, with overhead included, accounted for 57% of the total cost and was the single greatest expense at each hospital. Although the cost differed between endografts, Ancure ($12,148) and AneuRx ($15,407), the additional stents or stent grafts used during Ancure repairs resulted in similar total costs for the procedure. Medical-surgical supplies, which included wires, catheters, and other equipment, accounted for 11% of total cost. Operating room time, anesthesia time, and recovery room usage were bundled into one cost center and represented 12% of total expense. Other vascular implants, such as stents, stent grafts not part of the endovascular device (Wallgraft, Boston Scientific, Natick, Mass), and prosthetic grafts, added a mean of $1116 (5%) to the procedure. The remaining four cost centers contributed at total of $3703, accounting for only 16% of the total cost when combined.

There were variations between hospitals for each cost center. Large differences were seen in the estimated cost for the endograft. This was because of variations in the amount of overhead assigned to the device. Without overhead, the mean cost for the endograft was $10,496, with less variation reported between hospitals. Additional stents were used to different degrees during EVAR at each hospital, resulting in a range of costs for other vascular implants. This was the result of surgeon practice, type of endograft used for repair, and individual patient anatomy. Smaller differences were reported for room, pharmacy, laboratory, and other services. The cost of radiology services was similar, except for one community hospital, where the interventions were primarily performed by a radiologist, that reported significantly greater expenses for the radiology cost center.

Reimbursement for DRG 110 versus DRG 111. Excluding the Maryland hospital, EVAR was reimbursed based on DRG 110 in 78% of cases (n = 153) and DRG 111 in 22% (n = 42). As expected, significant differences were found between hospital compensation for DRG 110 versus 111. For cases covered with DRG 110, the mean net loss was $2200 (SD, $6554; Table IV). The mean net loss for cases reimbursed with DRG 111 was significantly greater at $9198 (SD, $4974; Table V). The mean net loss for hospitals reimbursed with the DRG system was $3898. All hospitals had a net loss in revenue for cases paid with DRG 111, and two university hospitals profited for cases paid with DRG 110. This was mainly the result of the higher reimbursement at these hospitals and not the result of lower costs. The Maryland medical center was excluded from the previous analysis because reimbursement was not directly related to the DRG classification.

Analysis including outliers. Cost analysis without outliers is useful to measure the cost of the average admission. However, with an active endovascular program, complex cases requiring additional supplies and longer admissions because of complications are predictable. To evaluate the global cost of EVAR, the analysis was done with inclusion of outliers (n = 3) greater than three SDs from the mean. The mean length of stay increased to 2.9 days after inclusion of these patients. With outliers, the mean total cost increased to $24,649 and the mean DRG-WR was $19,453. The net financial loss for all patients undergoing EVAR increased to $5196 from $2162.

DISCUSSION

Advances in medical technology, such as novel drug therapies and devices, are often associated with increased costs compared with established treatment methods. To date, this has been the case with EVAR. EVAR provides an excellent alternative to traditional open repair in many patients. More patients are requesting or demanding this option as public awareness about the procedure increases. As the clinical efficacy of EVAR continues to be studied and debated, the cost of this technology to hospitals must be considered. Previous reports have focused on the cost of EVAR in comparison with open repair.[1-11] Many studies have documented a higher cost of EVAR, mainly from the endovascular graft.[2,3,7,8,11] Sternbergh and Money[7] ana-

Table IV. Number, mean total cost, payment, and net profit or loss for cases in DRG 110

Hospital	*n = 153*	*Total cost*	*DRG 110 payment*	*Net profit or loss (–)*
University affiliate	63	$21,459	$21,310	–$149
University	12	$25,574	$27,135	$1562
University	11	$20,978	$27,460	$6482
Community	27	$28,494	$17,500	–$10,994
Community	30	$20,362	$19,016	–$1346
Community	10	$26,640	$17,886	–$8754
Mean		$23,918	$21,718	–$2200

Table V. Number, mean total cost, payment, and net profit or loss for cases in DRG 111

Hospital	*n = 42*	*Total cost*	*DRG 111 payment*	*Net profit or loss (–)*
University affiliate	13	$21,553	$11,719	–$9833
University	4	$20,149	$14,923	–$5226
University	8	$19,730	$15,150	–$4580
Community	5	$26,669	$9500	–$17,169
Community	6	$16,283	$10,458	–$5825
Community	6	$22,259	$9705	–$12,554
Mean		$21,107	$11,947	–$9198

lyzed the cost of EVAR with one device implanted under phase I and II clinical protocols. The authors found that EVAR was more costly than open repair if the device cost exceeds $5000. In addition, the 1999 mean blended Medicare reimbursement of $18,989 did not cover the cost of EVAR.

In this survey, hospital reimbursement weighted by DRG case mix resulted in an average loss of between $2162 and $3827 depending on the method of assigning reimbursement in Maryland. All hospitals in the study incurred financial losses for EVAR cases paid with DRG 111. Unexpectedly, losses also occurred for cases with the higher DRG 110 in four hospitals. Hospital net profit or loss for EVAR is highly dependent on DRG reimbursement. Payment for DRG 110 is greater than DRG 111 because this grouping includes major cardiovascular procedures with complicating conditions. Accurate coding of comorbities and complications is required to assure payment for all allowable cases in DRG 110. Reimbursement for EVAR at university medical centers and urban hospitals is generally greater than at nonteaching, rural hospitals. Community hospitals with low DRG 110 payments may find it difficult to sustain EVAR programs, especially given expensive start-up costs.

These results have important implications for EVAR. If other hospitals have similar losses, reluctance to start new programs or pressure to limit EVAR application may escalate. Hospitals with DRG weighted payments below total costs may have significant financial losses from a high-volume EVAR program. Losses may even be higher when treating high-risk individuals as shown with our analysis with the outliers.

If the number of endovascular repairs continues to increase, focus will undoubtedly be placed on minimizing expenses. With an already short length of stay, it will be difficult to further reduce expenditures without a reduction in endograft cost. This seems to be unlikely in the present environment, given the high development cost for these devices. As more endografts receive US Food and Drug Administration approval, however, competition may alter the economics of device pricing. The only other alternatives for reducing losses would have to use different reimbursement models.

Several limitations exist in our study. First, the study may not be representative of the national practice patterns. It is only a limited survey of costs and reimbursement at seven US hospitals and is not universally applicable, although we included university and community hospitals from various regions of the country to make the results more representative. Only EVAR with the two commercially approved devices was considered here to sample costs of current practice. Most repairs in the study were performed with the Ancure device as compared with the more widespread use of the AneuRx in current clinical practice. Therefore, costs presented here may not reflect the true actual costs for EVAR across the United States. A limited analysis of our data does not reveal major differences in the overall cost between devices.

Second, different accounting methods were used by the hospitals. We solicited cost data from hospitals on the basis of existing accounting systems because it was impossible to apply a standard accounting methodology. RCC accounting is a common method for calculating hospital costs.[14,15] An advantage of the RCC method is that it is the most widely used across hospitals nationwide. The main disadvantage is that the RCC may not accurately calculate costs for a specific procedure and at the individual case level. This is especially true for procedures such as EVAR in which

medical supply costs are high. In addition, the Medicare RCC does not cover certain nonallowable hospital expenses and may underestimate true costs. Costs provided by hospital finance departments were validated with review of UB forms to correct gross errors. The most common findings were failure to charge for the endograft. However, after correcting for these errors, the authors' best estimates of hospital costs were similar. Clear explanation and documentation of accounting methods are necessary for future cost analysis of EVAR. The previous issues illustrate the inherent problems in arriving at the real hospital costs in any study of this kind.

A third limitation is that only inpatient costs were factored in the analysis. The cost of endovascular surveillance and professional fees were not included. The costs of readmission for complications and secondary procedures, such as the treatment of endoleaks, were also not considered. These are not germane to the purpose of this review because they are reimbursed separately. Whether this additional activity benefits the hospitals financially or exaggerates the losses cannot be gleaned from our analysis. Finally, the initial capital required to establish an endovascular program is substantial. Additional fluoroscopic equipment alone ranges from $180,000 for a 12-in mobile C-arm to $1.5 million for fixed angiosuites being installed around the country in the operating rooms.

In addition, the effect of treatment was not measured in terms of the cost effectiveness of EVAR as reported by Patel et al[3] in a hypothetic model. The authors concluded that EVAR was cost effective even if the endograft cost was $8000 to $12,000. With a mean endograft cost of more than $13,000 with overhead and an additional $1100 from additional vascular implants, the cost of the procedure is at or above this threshold. A comprehensive analysis of the cost benefit ratio of EVAR on a real patient cohort is necessary to validate this assumption. This study was intended to review the cost of EVAR only from the hospital's perspective and does not address the larger issues of cost effectiveness.

CONCLUSION

EVAR was inadequately reimbursed at the hospitals included in this study. The endograft continues to be the single highest expense of repair. Internal analysis by individual hospitals and larger prospective surveys of hospital costs throughout the United States are necessary to determine whether these findings are more broadly applicable. A reappraisal of Medicare reimbursement to hospitals for EVAR may be warranted.

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DISCUSSION

Dr Jeffrey W. Kronson (Whittier, Calif). We are struggling with a lot of these same problems in our own community hospital in California. And I was wondering if you could comment on what seemed to be the disproportionate amount of DRG 110 payments, almost 80% of the cases, which would imply that 80% of the stent graft cases suffered from complications and were being paid out that way with only 20% being uncomplicated. Could you please comment on that?

Dr Daniel J. Bertges. Your question is why there seems to be a high proportion of DRG 110 cases. The DRG 110 does not only include complications as a result of the procedure. It also includes associated comorbidities that are present before the procedure. From our research, 70% to 80% of endovascular AAA repairs will be covered under DRG 110. One point I wanted to bring out is that hospitals can try to improve their bottom line through accurate coding.

Dr Clifford J. Buckley (Temple, Tex). We have looked at this same issue in our own institution. Placing endografts in patients that are truly poor candidates for direct surgical repair should put their reimbursement under DRG 110, abdominal aortic aneurysm with multiple comorbidities.

If the majority of your endograft patients are discharged in 48 hours or less, your hospital should realize a profit using the DRG 110 level of reimbursement.

Dr Bertges. In our study, the mean length of stay was 2.4 days. The number one cost of the admission was the endograft, which accounted for nearly 60% of the total cost. Despite minimizing the time in the hospital, endovascular AAA repair resulted in a net loss.

Dr Julie Ann Freischlag (Los Angeles, Calif). We looked at costs at our hospital comparing endograft versus open repair of abdominal aortic anerusysms and found, obviously, the hospital made a lot more money if we did an open repair versus the endograft repair. Our reimbursement was around $21,000. Did you look at open repair in these hospitals to compare it with the endograft repair?

And second, one of the strategies is to try to get more money for these procedures, but that does not seem to be working very well with healthcare corporations and Medicare. Do you have any strategies to decrease the cost of the graft or the other supplies it takes to put it in?

Dr Bertges. We did not, to answer your first question, look at open repairs. This study was designed to provide a survey of cost and reimbursement of endovascular repair.

As to ways to minimize costs, that is certainly an interesting question. In our viewpoint, I think the initiative for any type of push to increase the reimbursement should probably come from hospital organizations. And as a vascular surgery community, we can help by, number one, providing good documentation in the medical record so your individual hospitals can get their allowable DRG payment; but on a broader scale, we could provide some support as to the clinical issues behind endovascular repair. But whether we should be leading a charge to try to increase hospital reimbursement or not, I am certainly not prepared to advocate that. Perhaps as more devices enter the market the cost of the endograft will decrease.

Dr William D. Turnipseed (Madison, Wis). The traditional determinants for hospital cost are hospital length of stay and ICU utilization with a corisk modifier of inhospital morbidity. You have basically reduced hospital stay to the minimum by using the endograft technology and are afflicted by the cost of the technology, which overwhelms the advantage of reduced ICU utilization and reduced hospital stay.

A caveat is that there are alternative less-invasive techniques emerging that have comparable morbidity lengths of stay. In our institution, for example, minimal incision aortic surgery has nearly the same clinical outcome profile as an endograft; however, the cost is much less. It cost our hospital $10,000 to put in an endograft. The hospital makes $10,000 if we do a minimally invasive open repair.